Study of waveforms in AMANDA'S STRING-18

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ICECUBE – the cubic kilometer scale expansion of the AMANDA neutrino telescope at the south pole – will be equipped with fully digital technology. The signal from the photomultiplier tube is digitized in the *Digital Optical Module* (DOM) in the ice at about 2 km depth [1]. AMANDA'S STRING-18 represents a prototype of this digital technology and has been deployed as part of the AMANDA array. So far, STRING-18 has served mainly as a proof of principle for this new technology.

In addition to an increased reliability in operation as compared to the analog technology of the previously deployed AMANDA strings, the digital technology also provides waveform data, which represent the shape and time distribution of observed PMT pulses. Just recently we have begun to explore the science potential inherent in this additional information.

By studying the time distribution of pulses of the PMTs of STRING-18 we have gained insight into the problem of the observed noise in the AMANDA *Optical Modules* (OMs). The high noise level observed has been a serious problem from the beginning of operating AMANDA. Apart from generating an abundance of irrelevant hits in the OM it is a waste of communication bandwidth if all these noise hits are digitized and transmitted. Moreover, the intrinsic correlation of the noise specifically compromises the detection of supernovas [2].

On the one hand, we have developed a compression algorithm to reduce the amount of data to be send to the surface by a factor of more than 10 without compromising the information content relevant for analyzing the waveforms.

Also, we were able to identify the cause of the high noise level and the intrinsic correlation. We found conclusive evidence that the glass of the pressure spheres emits light when energy e.g. from radioactive decays is deposited in the glass. The results were obtained by irradiating the glass with radioactive sources as well as by studying the time distribution of PMT signals. Our observations indicate that the glass used for the pressure spheres has a rather high efficiency for detecting a decay of ^{40}K and other radioactive isotopes contained in the glass material itself.

Scintillation of the AMANDA pressure sphere glass has been found to be the prime source of the noise of the AMANDA OMs. Moreover, the long decay time of the luminescence is found to be the cause for the correlation of the noise. Fig. 1 shows the reaction of the glass to both irradiation by external sources as well as radioactive decays in the material itself.

We have shown that eliminating potassium from the glass does not by itself completely remove the noise. Rather, the natural radioactive decay chains contribute substantially to the noise level. Removing these trace elements from the glass or adding rare earths in appropriate ratios to quench the scintillation might reduce the noise impact for future ICECUBE OMs.

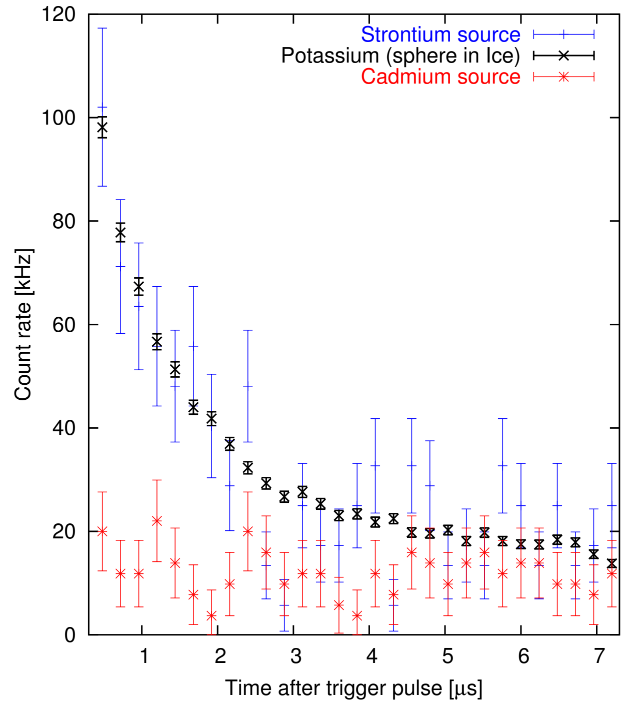

FIG. 1: Time distribution of light in pressure sphere glass due to external irradiation and intrinsic radioactive decays

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